Complex Tongue Shaping in Lateral Liquid Production Without Constriction-Based Goals

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PRODUCTION OF LATERAL LIQUIDS

- Tongue tip makes contact with alveolar ridge
- Tongue blade lowered/curled
- Tongue body retracted

What are the main tasks associated with lateral liquid production?

- Hypothesis 1: Creation of side channels (tongue tip contact + tongue blade curling/lowering) is a main production task for /l/
- Hypothesis 2: Tongue blade curling is a main production task for /l/
- Sequencing of tongue tip contact and tongue body retraction varies by syllable position (Sproat & Fujimura 1993)
- Full tongue tip closure often not achieved during production of /l/ in syllable coda position: /l/ vocalization (Hardcastle & Barry 1989)
- Variability vs. stability of achievement of tongue tip contact and its timing across syllable positions may point toward true production goals of /l/

IMAGE ACQUISITION & ANALYSIS

- MRI-TIMIT database at USC: balanced corpus of 460 sentences
- Two female speakers of American English
- Temporal resolution: 23.18 frames per second
- Field of view: 68 x 68 pixels (200 x 200 mm)
- Lay grid of ≈30 lines orthogonal to vocal tract
- Air/tissue boundaries for upper and lower surfaces of vocal tract found for each gridline

MEASUREMENTS

- Tongue blade curling:
  - Down-sample tongue contour to fifteen evenly spaced points
  - Calculate radius of circle passing through each set of three contiguous points along tongue
  - Curvature score = 100/radius
  - Negative curvature score if circle lies outside tongue contour
  - Positive curvature score if circle lies within tongue contour
- Rate of vocalization: percentage of tokens produced without contact between tongue tip and alveolar ridge/teeth
- Temporal measurements:
  - Frame of achievement of tongue tip contact with alveolar ridge/teeth
  - Frame of greatest degree of negative curvature along tongue blade
  - Frame of greatest tongue body retraction

RESULTS: RATE OF GESTURAL ACHIEVEMENT

- Tongue blade curling (negative curvature) observed in all /l/ tokens
- Greater rate of vocalization (no tongue tip contact) in nucleus and coda positions than in onset and intervocalic positions:

RESULTS: GESTURAL SEQUENCING

- Lag between tongue tip contact/tongue blade curling and tongue body retraction of /l/ varies by syllable position:
  - Onset and intervocalic positions: tongue tip closure/tongue blade curling precede tongue body retraction
  - Nucleus and coda positions: tongue body retraction precedes tongue tip closure/tongue blade curling
  - All positions: magnitude of lag is substantially less between tongue bladecurling and tongue body retraction than between tongue tip contact and tongue body retraction

TONGUE TIP CLOSURE AS BRACING

Tongue Tip Closure → Maximal Curvature → Tongue Body Retraction

- Tongue tip contact is followed by greater degree of tongue blade curling

Time course of production of /l/ in the word ‘black’

Onset/intervocalic tongue tip contact is a form of bracing to facilitate tongue blade curling

Tongue Body Retraction → Maximal Curvature → Tongue Tip Closure

Time course of production of /l/ in the word ‘help’

Tongue blade curling is a main production task for /l/